The influence of nutrition on the periparturient rise in fecal egg counts in dairy goats : results from a two-year study

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SUMMARY

The periparturient relaxation in immunity (PPRI) to nematode infection in ewes is well known and it is associated with a rise in faecal egg counts during the periparturient period. In order to assess an eventual relationship between the PPRI and the nutritional status of periparturient females, a two-year study was carried out in a dairy goat flock. On year 1, pregnant does were fed at 26 % below their energy (UFl) requirements and 5 % above their protein (PDI) ones during the last 3 weeks before parturition (week 0) and an increase in nematode egg counts occurred from week -2 to week +4 with a predominance of *Oesophagostomum* larvae in coprocultures. In year 2, two groups of pregnant goats were fed at about 100 % their energy requirements and 28 and 44 % above the protein requirements respectively during the same period. In this latter situation, no nematode egg count increase occurred in any of the two groups of animals, *Teladorsagia* and *Trichostrongylus* being the prevalent larval genera in coprocultures. As the study covered two consecutive years, the implication of several factors related to host physiology, parasite epidemiology and host nutrition are discussed.

KEY-WORDS : periparturient relaxation in immunity - nutrition-parasite interaction - epidemiology - goat.

RÉSUMÉ

Influence de la nutrition sur l'élévation coproscopique d'œufs de strongles autour de la mise-bas chez la chèvre laitière : résultats d'une étude sur deux années. Par E. ETTER, C. CHARTIER, H. HOSTE, I. PORS, W. BOUQUET, Y. LEFRILEUX et L.P. BORGIDA.

Le relâchement de l'immunité vis-à-vis des nématodes parasites autour de la mise-bas chez la brebis est bien connu et est associé à une élévation des valeurs coproscopiques autour de la mise-bas. Afin de déterminer une éventuelle relation entre ce phénomène et le statut nutritionnel des femelles autour de la mise-bas, une étude sur 2 années a été conduite dans un troupeau de chèvres laitières. En année 1, les chèvres gestantes ont reçu une ration déficitaire de 26 % pour les besoins énergétiques et excédentaire de 5 % pour les besoins protéiques durant les 3 dernières semaines de gestation : elles ont présenté une élévation des valeurs coproscopiques de la seconde semaine avant à la quatrième semaine après la mise bas avec une prédominance de larves de type *Oesophagostomum* dans les coprocultures. A l'opposé, en année 2, deux groupes de chèvres gestantes ont reçu une ration couvrant les besoins énergétiques à 100 % et dépassant les besoins protéiques respectivement de 28 et 44 % durant la même période. Dans cette dernière situation, aucune augmentation des valeurs coproscopiques ne s'est produite dans aucun des groupes, *Teladorsagia* et *Trichostrongylus* étant les larves les plus fréquentes dans les coprocultures. Etant donné que l'étude s'est déroulée sur 2 années consécutives, l'implication de plusieurs facteurs reliés à la physiologie de l'hôte, à l'épidémiologie des parasites et à la nutrition de l'hôte sont discutés.

MOTS-CLÉS : relâchement de l'immunité autour de la mise-bas - interaction parasite-nutrition - épidémiologie - chèvre.

1. Introduction

Ewes usually show a marked rise in nematode egg production during the periparturient period which is related to a periparturient relaxation in immunity (PPRI). This phenomenon, described also in goats [1, 6, 15, 16], is due to a resumption of development by inhibited larvae, and/or a greater establishment of incoming infective larvae, and/or a higher fecundity of pre-existing adults [21] suggesting that all of the parasitological manifestations of acquired immunity to nematodes may be compromised. Although the PPRI is concomitant with elevation of prolactin and other major changes in hormonal balances, it seems that the hypothesis of hormonal suppression of immunity as a main cause of PPRI does not adequately explain the phenomenon and that some other etiology such as nutritional stress around parturition should be advocated [2].

On the other hand, nematode infection in ruminants is associated with a decrease in feed intake and feed utilisation efficiency, especially for protein [5]. The elevated endogenous loss of protein in the parasitised host can be counterbalanced with supplementation of the diet with additional protein. Reviews [5, 23] have focussed on the effects of protein supplementation on the acquisition of resistance and the expression of resilience in growing lambs. However, only a few works have dealt with the effect of different levels of energy and/or protein in the diet on the periparturient parasite status of ewes and conflicting results were obtained. In a first study [8], it was demonstrated that manipulation of energy 7 weeks before lambing (30 % above *vs* 22 % below requirements) leads to different faecal egg counts and worm burdens (*Teladordagia circumcincta*) at lambing, values being higher in the low plane of nutrition. In a second work [9], pregnant ewes were trickly infected with *Teladorsagia circumcincta* and *Trichostrongylus colubriformis*, according to a 2 x 2 design for energy and protein levels. The results showed that faecal egg counts were ten fold higher in the low (120 g CP/kg DM) than in the high (200 g CP/kg DM) protein diet whereas no effect of energy level (0 g *vs* 50 g/d gain in body weight) was noted.

In a previous study, we have demonstrated the occurrence of PPRI in a dairy goat flock from 2 weeks before to 2 weeks after parturition [4]. As the pregnant goats were fed below their energy requirements during the 3 weeks before delivery, the plane of nutrition was changed the following year in order to cover energy requirements and to provide excess dietary protein prior to kidding. The comparison of these two consecutive years are presented in this paper.

2 Materials and methods

1) ANIMALS AND EXPERIMENTAL DESIGN

The study was performed on an Alpine dairy goat farm located in western part of France with 80 lactating animals. Animals grazed throughout the year; from early spring to mid-winter they grazed on festuque-lucerne or grass (*Bromus cantharticus*) with additional kale grazing offered in winter in both years. Goats were given hay, maize and commercial concentrates indoors. Animals were drenched once or twice a year with benzimidazole compounds.

In year 1, 21 pregnant goats at the 3rd month of lactation were selected as well as 7 non-pregnant animals which acted as controls. On these pregnant goats, a periparturient rise in faecal egg counts was seen 5 weeks around parturition that occurred in March. Moreover, a significant correlation between faecal egg counts and prolactin concentrations was recorded 4 weeks around parturition [4]. The nutritional status in late pregnancy (diet 1) was assessed *a posteriori* and indicated that pregnant goats during the last 3 weeks of pregnancy were fed at 26 % below their energy (Unités Fourragères lait, UFl) requirements whereas protein (Protéines Digestibles dans l'Intestin, PDI) requirements were covered [13] (Table I).

	Requirements coverage		
	Ufl (%)	PDI(%)	PDIA (in % of PDI)
Diet 1	74	105	55
Diet 2	96	128	65
Diet 3	96	144	91

average requirements : 1.42 Ufl, 128 PDI

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TABLE I. — Characteristics of the different diets offered to pregnant goats for the 3 weeks before delivery.
(Ufl : Unité Fourragère lait ; PDI : Protéines Digestibles dans l'Intestin ; PDIA : Protéines Digestibles dans l'Intestin d'origine Alimentaire).

The following year, 2 x 20 pregnant dry goats were selected and there were no available lactating control animals as the farmer decided to have only one kidding period in February. During the 3 weeks before parturition goats were fed at either 28 or 44 % above PDI requirements (diet 2 or 3 respectively) while UFl requirements were covered in both groups (Table I). From the parturition onwards all group of goats received the same diet.

2) SAMPLING AND LABORATORY PROCEDURES

Fecal and blood samples were taken individually at weekly intervals from week -5 to week +4, week 0 being the date of kidding.

Fecal egg counts [17] and coprocultures [11] were performed with standard procedures. Pepsinogen concentrations related to abomasal strongyles and inorganic phosphate concentrations related to intestinal strongyles were determined according to KERBOEUF [14] and ROBINSON *et al.* [19]. Blood eosinophil counts were assessed according to DAWKINS *et al.* [7].

Three culled goats were necropsied at the end of the grazing season in year 2. The digestive tract process and worm counts were performed as previously described by EUZEBY [10].

Data were analyzed with Kruskal-Wallis non parametric test using Statmost 2.5 as software.

3. Results

Mean fecal egg counts in each group of goats are summarized in Table II. Whereas a significant rise in egg output up to 962 epg was recorded in diet 1 group of goats from week -2 to week +4, egg excretions in control as well as in diet 2 and 3 groups were steadily ranging between 200 and 500 epg without any increase until week +4. In year 1, in March, coprocultures indicated that the genera *Teladorsagia* and *Trichostrongylus* were predominant until week -3 before delivery (59 to 91 % of the larvae recovered) when a switch occurred with *Oesophagostomum* larvae becoming predominant during the second part of the survey (72 to 95 % of the larvae). Coproscopical examinations also showed the occurrence of *Dicrocoelium lanceolatum* and *Trichuris* sp eggs. In year 2, in February, *Teladorsagia* and *Trichostrongylus* represented more than 92 % of the larvae throughout the survey, *Oesophagostomum* accounted for the remaining larvae. The examination of the 3 culled goats showed moderate total strongyle burdens (1120, 1020 and 10960) with *Teladorsagia circumcincta* representing 83.3 % of adult worm populations, *Oesphagostomum venulosum* 16,1 % and *Trichostrongylus colubriformis* only 0.6 %. *Dicrocoelium lanceolatum*, *Trichuris* sp and *Skrjabinema* sp were also noted.

Pepsinogen and phosphate concentrations were similar between the 4 groups and showed no fluctuation for the former parameter and a regular but slight decrease throughout the study for the latter (data not shown). Blood eosinophil counts in control goats showed irregular variations without any

	Weeks before (-) and after (+) parturition									
	-5	-4	-3	-2	-1	0	+1	+2	+3	+4
Control *(non-pregnant)*	421	664	500	286	242	507	279	400	478	464
Diet 1	335	467	437	564	667	867	962	950	802	780
Diet 2	274	245	225	205	387	329	450	317	341	272
Diet 3	345	257	205	272	362	347	415	317	292	287
Level of Significance *(Kruskal-Wallis test)*	n.s.	n.s.	n.s.	0.01	0.05	0.01	0.01	0.01	0.01	0.01

TABLE II. — Nematode egg outputs from 5 weeks before to 4 weeks after parturition according to reproductive and nutritional status.

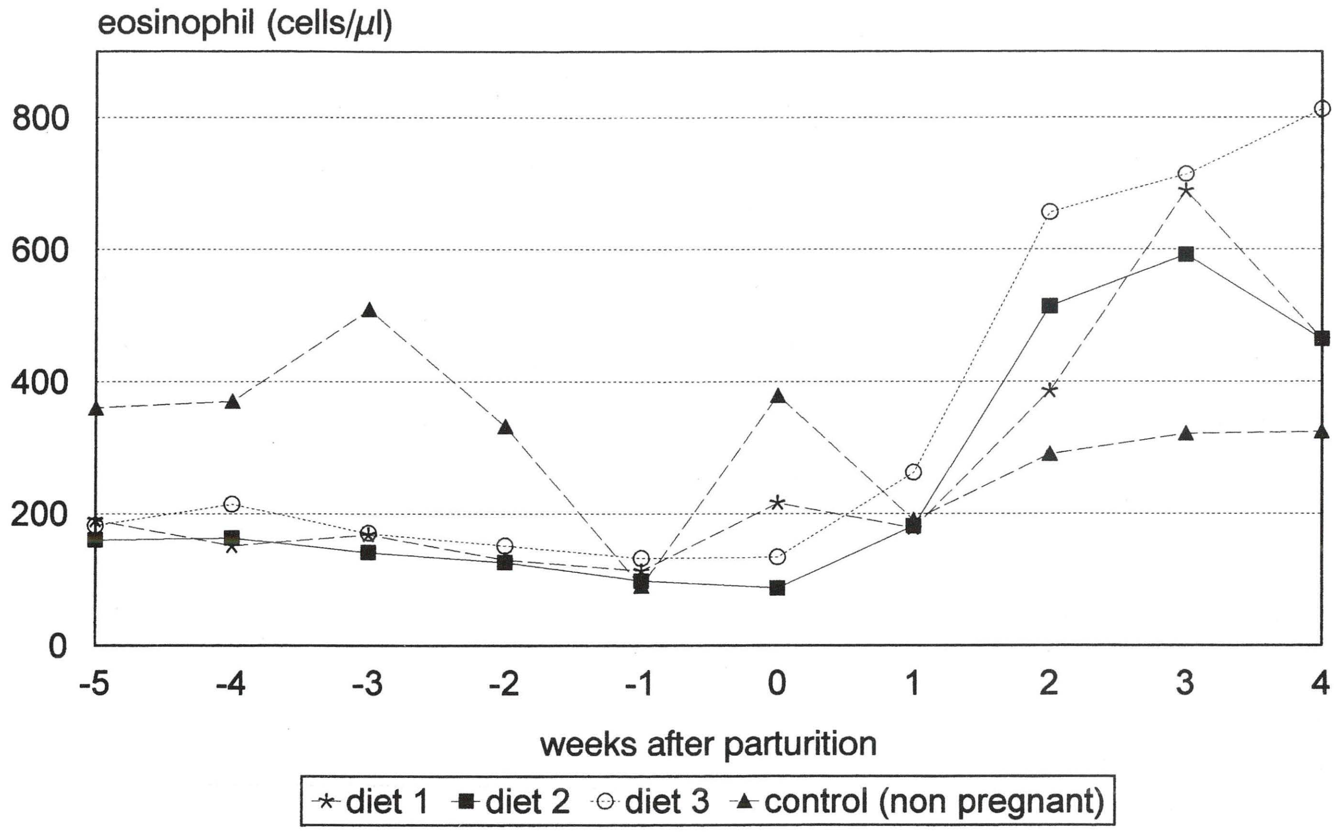

FIGURE 1. — Peripheral eosinophil counts (cells/µl) from 5 weeks before to 4 weeks after parturition according to reproductive (diets 1 to 3) and nutritional status (pregnant or non- pregnant).

obvious trend (Figure 1). Mean values ranged between 90 and 509 cell/µl. At the opposite, the 3 groups of kidding goats had very low and steady eosinophil counts between 100 and 200 cell/µl until the parturition and then exhibited a clear increase between week 0 and week +3-4 with peak values ranging from 592 to 813 cell/µl according to the groups.

The prolificity of kidding goats was recorded in each group : 2.13, 1.85 and 2.05 for diet 1, diet 2 and diet 3 respectively, these differences being not statistically significant.

4. Discussion

The increase in nematode egg output 4 weeks around parturition in goats receiving diet 1 compared to lactating non-pregnant animals was recorded during the first year of the survey [4]. The following year, the periparturient rise did not occur in the animals receiving diet 2 or diet 3 as egg excretions remained at a stable and low level similar to those of control in year 1. Four hypothesis related to host physiology, parasite epidemiology or host nutrition can be evoked to explain this absence of PPRI in year 2.

Host prolificity has been associated with variations in the intensity of the PPRI, females bearing more lambs or kids having a more pronounced increase in faecal egg counts [1, 12, 15, 20]. Although litter size was slightly higher in our study in year 1 (2.13 *vs* 1.85-2.05), this difference was not significant.

The general management of the goats was similar during the two consecutive years and the nematode egg outputs were very close at the beginning of each survey. Nevertheless the composition of larvae recovered from weekly coprocultures showed between-year variation as *Oesophagostomum* represented more than 72 % of the larvae in kidding goats in year 1 but less than 8 % in the following year. *Oesophagostomum* is known to be a nematode with a high fecundity like *Haemonchus* whereas *Teladorsagia* (*Ostertagia*) and *Trichostrongylus* females have a low egg production [18]. The intensity of periparturient rise in nematode egg output could be dependent of the faunistic composition of the worm burdens of the host, the increase being more pronounced when highly prolific worm species are present. Moreover, the loss of immunity may be nematode species-specific as the modulation of immunity can affect differently the various worm species as demonstrated in lactating ewes [2, 9].

The kidding period in the second year was brought forward by about one month compared to the first one. PPRI occurred in year 1 in March while it was absent in year 2 in February. Although the two dates seem to be very close, March corresponds to the beginning of spring in France, a time of the year associated with major changes in the epidemiology of digestive strongyles [3]. Seasonal effects on the periparturient rise have previously been described in goats [6] and sheep [22] and were considered to be related to both increased levels of infective larvae available on pasture and resumption of development of inhibited larvae. However this hypothesis is not supported by the pathophysiological data presented here. Pepsinogen and inorganic phosphate values did not fluctuate during the surveys and were similar in the control and the kidding goats. This lack of variation suggests that maturation of hypobiotic larvae or/and ingestion of infective larvae did not occur at least for *Teladorsagia* and *Trichostrongylus* species.

According to WANYANGU *et al.* [24], periparturient rise is probably due to a relaxation of local immunity caused by both a transfer of effector cells and antibodies to the udder as well as a nutritional stress at the end of pregnancy and beginning of lactation. The major difference between year 1 and year 2 was the level of energy and protein distributed through the concentrates 3 weeks before kidding. The diet 1 in year 1 was under the energetic requirements (74 %) and covered the protein requirements while the diets 2 and 3 in year 2 covered the energetic requirements and were in excess of 28 and 44 % respectively regarding the protein requirements. In addition ruminally undegradable proteins (PDIA) differed between the 3 diets and ranged from 71 g in diet 1 to 116 g in diet 3. As periparturient rise was observed only in goats that were given diet 1, it is difficult to distinguish the respective part of energy and protein level on the expression of PPRI in our study because both of them have changed between year 1 and 2. Nevertheless it seems likely that nutritional status in late pregnancy could have an effect on faecal egg output around parturition. Our results have to compared to those of DONALDSON *et al.* [8, 9] who have demonstrated the influence of energy and/or protein when given below requirements on PPRI in ewes.

The results of the present study showed that periparturient relaxation in immunity could be related to the level of nutrition before parturition in dairy goats. However, further information about the respective influence of energy and protein components on the modulation of PPRI are needed before this approach to reduce the larval contamination of pasture can be evaluated in the field.

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